Paper

How useful is dual energy lateral vertebral assessment in a clinic setting?

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ABSTRACT

Screening for osteoporotic vertebral fractures traditionally involves X-ray of the thoracic and lumbar spine. We evaluated use of dual energy X-ray technology in patients with osteoporosis. We found this technology useful in the clinic setting and it has advantages in that less radiation is delivered to the patient.

INTRODUCTION

Osteoporotic vertebral fractures are a major cause of morbidity. Those who have had a vertebral fracture are at an increased risk for future fracture but this risk is significantly reduced by appropriate treatment[1]. Many of these fractures cause little or no pain and it is has been suggested that less than one third are diagnosed clinically[2].

The use of routine x-rays for screening is inappropriate but dual energy X-ray technology can be used to assess vertebral morphometry with much less radiation exposure. We have assessed the practicality of using this technique in a clinic setting.

METHODS

Subjects

An osteoporosis specialist nurse assessed each patient attending an outpatient osteoporosis clinic. Those with suspected vertebral fracture were eligible. If a patient had suffered new onset of back pain, loss of height or a recent fall they were asked if they would like to participate, and 95 patients were enrolled. Written informed consent was obtained. The study was approved by the Queen's University of Belfast Ethics Committee.

Vertebral Morphometry

Dual-energy X-ray absorptiometry was performed by lateral vertebral morphometry (LVM) using a Hologic 4500A densitometer. Time taken to carry out this study was recorded for the first fifteen patients. The LVM image was evaluated independently by two non-radiologist clinicians (BMcG, HT) and agreement was reached after discussion.

Radiography

Patients had lateral thoracic and lumbar spine X-rays at the clinic or equivalent X-rays taken within the preceding three months were accepted. These images were independently and blindly assessed by the non-radiologist clinicians (BMcG, HT) using a digital calliper to calculate anterior, mid and posterior heights to the nearest one-hundredth of a millimetre.

All adequately visualised vertebrae (using both methods) were evaluated using an established semi quantitative visual scoring system[3,4]. A grade 1 fracture (mild) was defined as a 20-25% reduction in either anterior or middle or posterior height relative to the adjacent vertebral bodies; a grade 2 fracture (moderate) was 25-40% reduction in any height and a grade 3 fracture (severe) was a reduction of greater than 40% in any height.

Statistical Analysis

The grade of fracture seen on X-ray compared to that on LVM was evaluated using the weighted kappa score. Only those vertebral bodies that could be adequately visualised on LVM were included in the kappa score calculation.

RESULTS

95 subjects were recruited for this study over a three-year period, 70 females and 25 males. Age ranged from 29-89 years, mean age 59.5 (s.d.14.2) in males and 65.9 (s.d.11.3) in females. All patients had T scores <- 2.5 at lumbar spine.

LVM Analysis

There was difficulty analysing some of the upper thoracic vertebrae. L4 to T12 only was seen on one patient's images, L4 to T10 in 5 patients' images, L4 to T8 in 8 patients' images, L4 to T7 in one, up to T6 in 22 patients' images and L4 to T5 in 10 patients' images. In the remaining 48 patients images L4 to T4 was adequately visualised. An example of an image obtained is shown in Figure 1 with a crush fracture of L1 clearly visible. Of 1235 potentially evaluable vertebrae from T4 to L4, 1108 (89%) were adequately visualised. Mean time taken to complete the study on the first 15 patients was 19 minutes.

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Vertebral Fracture Analysis

The number of vertebral fractures per patient ranged from 0 to 9 on X-ray. 12 patients had no fractures, 41 patients had 1 fracture, 21 patients had 2 fractures, 7 patients had 3 fractures and 14 patients had 4 or more fractures. In total 173 fractures were detected on X-ray.

Agreement between LVM and radiography

20 fractures visible on X-ray could not be visualised on LVM and so were not included in kappa score calculation (20/173=11%). A weighted kappa was used and overall agreement was very good (0.82; 95% CI 0.72, 0.92). There were no false positives with LVM analysis when compared to x-ray examination. There was one grade 1 fracture not seen on LVM, 3 grade 2 fractures not seen on LVM and one grade

Fig 1. Example of an image with a crush fracture of L1 clearly visible.

3 fracture not seen on LVM. There was one grade 1 fracture graded as 2 on LVM, four grade 2 fractures graded as 1 on LVM, two grade 2 fractures graded as 3 on LVM and six grade 3 fractures graded as 2 on LVM. Apart from this there was agreement between both methods [Table I].

DISCUSSION

LVM assessment of vertebral fractures is comparable in efficacy to radiography if adequate images are obtained. Most difficulty was found analysing upper thoracic images especially T4-T6 as there was interference from the lungs. The weighted kappa statistic of 0.82 implies very good agreement between both methods. LVM was able to detect 88.4% of fractures visible on X-ray; there were 20 fractures visible on X-ray that were not detected on LVM. This is comparable to a previous paper in which clinicians correctly identified 94% of radiographically defined grade 2 and 3 vertebral compression fractures[5].

The advantages of LVM include less radiation to the patient. The radiation dose of one X-ray is 800μSv whereas the dose received from LVM is 19μSv per exposure. Images are collected at the same time as bone densitometry so there is ease of use for both patient and operator. The average time spend from consent to exit from scanner was 19 minutes so most patients found the method acceptable. The use of clinical triggers e.g. recent onset of back pain, led to the osteoporosis specialist nurse correctly identifying those patients who required additional imaging in most instances.

TABLE I:

Comparison of fracture grade between X-ray and vertebral morphometry

X-Ray Grade	LVM Grade				
	0	1	2	3	Total
0	12				12
1	1	13	1		15
2	3	4	51	2	60
3	1		6	59	66
Total	17	17	58	61	153

The disadvantages of LVM include the difficulty in assessing the upper thoracic vertebrae. Twenty of the fractures detected on X-ray but not on LVM were in the upper thoracic vertebrae. This methodology is more useful for assessing the lower thoracic vertebrae and the lumbar vertebrae. If there is any doubt, lateral thoracic X-rays should be obtained. There was difficulty at times in choosing the correct point placement for height measurement. Very small changes in point placement led to differences in fracture rate and training and experience were required to read the images correctly. There was also difficulty analysing the images if the patient had osteoarthritic changes in the vertebrae.

Limitations of the study

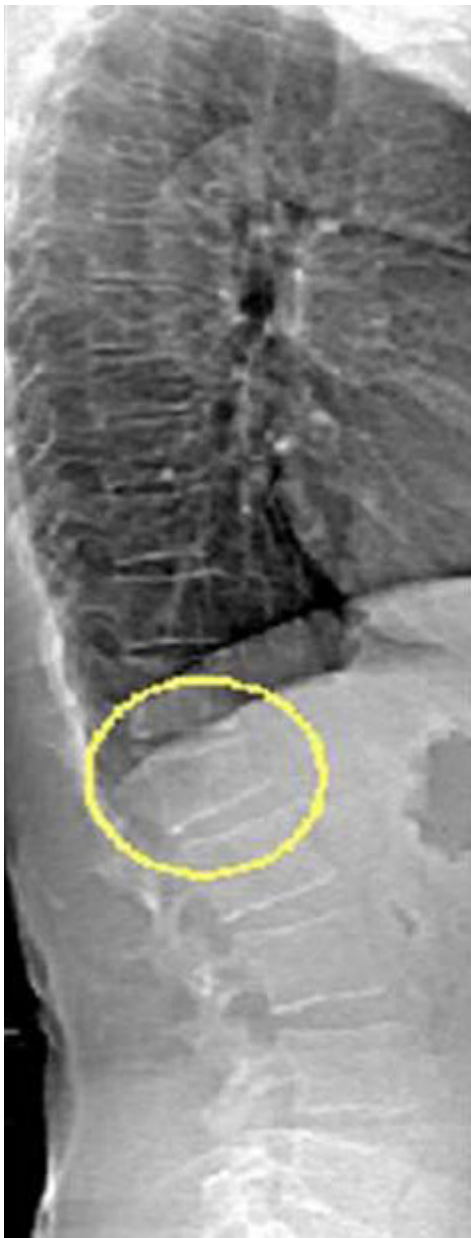We aimed to recruit as many patients as possible over a two-

year period. Due to time constraints at the clinic we were able to recruit only 95 patients. A larger group of patients would have improved statistical power. Another limitation was that the X-rays were not reviewed by a radiologist. A consultant with many years experience running osteoporosis clinics and a senior specialist registrar reviewed each film. Consensus was reached for each X-ray after discussion. The use of the digital calliper to measure vertebral height accurately also enhanced ability to detect each fracture.

Overall, LVM is a useful tool to assist in the diagnosis and management of osteoporotic vertebral fractures. It does not replace radiography, which remains the gold standard but is useful in a clinic setting reducing the frequency of patients' exposure to X-ray. This is particularly true for nurse/ radiographer led scan only clinics and it has been implemented in the local osteoporosis clinic.

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